Closeout Report

on the

Director's Review

of

BTeV CD-1

March 30 – April 1, 2004

REPORT OUTLINE

Executive Summary 3
1.1 Vertex, Toroidal Magnet, Beam Pipes 7
1.2 Pixel Detector 10
1.3 RICH Detector 12
1.4 EM Calorimeter 14
1.5 Muon Detector 17
1.6 Straw Detector 20
1.7 Strip Detector 22
1.8 Trigger Electronics and Software 25
1.9 Event Readout and Controls 27
1.10 Installation and Integration 29
2.1 Interaction Region 32
3.1 Building Outfitting 37
4.1 Project Management, Cost and Schedule 39

Appendices

Appendix A. Committee Charge
Appendix B. Agenda
Appendix C. Review Participants
Appendix D. Table of Recommendations

Executive Summary

The proposed BTeV project is ready for CD-1. Significant work is needed on presentations for DOE CD-1 Review including content and uniformity. Each plenary presentation should include in addition to the technical scope and status, an organization chart with names, schedule and milestones, cost estimate and risk identification/analysis.

The project is beyond the Conceptual Design stage on nearly all components. There are reasonable point estimates on the Detector and the Building Outfitting. The point estimate for the IR was presented as $43M and is judged to be in the plus or minus $7M range. (In our cost table spares are removed, a correction for HTS lead miscounting was made, and an increase made in WBS 1.10 that results in a net $8M reduction to the TEC and $1M addition to the TPC.) So the Total Project Cost range shown in Acquisition Strategy of $190 - $230M is felt to be appropriate with the current point estimate being ~$189M. The schedule and cost profile supporting the installation in the FY2009 shutdown and beginning of operation in calendar year 2009 are developed in the Open Plan scheduling tool.

Given that CD-2/3a approval is desired this summer, we looked at readiness for a CD-2/3a review. A lot of work must be done to reach this stage of readiness. The Detector TDR must be completed, and IR and Building Outfitting TDRs must be prepared. The detailed cost basis of estimate must be prepared for the IR and completely fleshed out for the Detector. The accompanying project management documents must be completed. The proposed project obligation profile must be made consistent with the profile of funding available. The pace and maturity of the project must increase dramatically to be ready for CD-2/3a.

A feature missing from presentations in this review were overall summary level schedules and tiered milestones. This should be addressed to the extent possible for the DOE CD-1 Review and must be well developed for the CD-2/3a Review. Furthermore, the Open Plan tool will need to be internalized and utilized for the on-going management of the effort well beyond the CD-2 baseline exercise.

Summary of the Technical Status of BTeV

The BTeV experiment is a single-arm forward spectrometer studying the properties of bottom hadrons produced in the Tevatron proton-antiproton collider. It emphasizes charged particle tracking and triggering using silicon pixels, silicon microstrip detectors and straw tubes, as well as emphasizing neutral particle reconstruction using a fine-grained lead tungstate (PWO) detector. Particle identification is achieved using both a gas and liquid Ring Imaging Cerenkov (RICH) detector for protons, kaons and pions, and a toroidal spectrometer for muons. The detector triggers on events containing muons or a secondary vertex from *b* quark decays. The BTeV project also includes the beam optics for the low-β insertion and associated building outfitting for the C0 detector hall.

The C0 interaction region requires construction of 10 new quadrupole magnets of a modified LHC design, using high-temperature superconducting leads. There are also 10 new spool pieces (two each of five kinds) that will need to be constructed. Conceptual designs for these magnets exist, but studies on the interaction between these magnets and the rest of the Tevatron (the Q2 magnet will be the strongest in the Tevatron and at the highest β location) are incomplete.

The analysis magnet and beampipe tasks are well understood, and are at or near the TDR stage. New magnetostatic modeling using ANSYS has been done to understand the new pole piece inserts similar to those that will be used in the final design. There are no spare coils for the vertex magnet. The use of recycled beryllium beampipes from CDF will result in substantial cost savings. Additional steel has been added to the toroid magnets to improve the mechanical tolerances for muon detector installation.

There are three elements to the tracking detector: silicon pixels, silicon strips and straws. Good progress has been made on all three fronts. The pixel cooling strategy based on liquid nitrogen cooling is plausible, and sufficient resources are now being devoted to this task (a concern of the October review). Studies on the effect of a loss of cooling are underway. Grounding, shielding and the risk of coherent noise in the silicon is a concern, and the study for an RF shield inside the inner radius is underway. At large angles, tracking is accomplished using Kapton straw detectors. Simulations show that the occupancies running at 396 ns are not as large as once thought (15-20% instead of 40%). Reducing these occupancies by increasing the radius of the silicon-strip to straw transition appears unfeasible: it would substantially increase the cost, reduce the overall tracking efficiency because of the increased multiple Coulomb scattering and would have only a ~15% effect on the straw occupancy. A plan to prototype a full half-view has been developed. The custom TDC ASIC development is at the conceptual phase.

The RICH detector uses two technologies - a mirror-focused gas radiator and a proximity-focused liquid radiator. Specifications for mirror manufacturing tolerance have been generated and some of the installation procedures have been worked out. Two choices for the gas RICH photodetectors had been tested and thus far found to be acceptable: hybrid photodiodes and multianode photomultipliers. BTeV has selected the MAPMTs as their technology choice based on cost and simplicity of the associated high voltage system.

The EM calorimeter is an array of ~10,000 lead tungstate blocks. These blocks have been tested in 2000 hours of beam at Protvino and show a resolution of 1.8%/sqrt(E) and a constant term of 0.33% and indicate that it is likely that the majority of crystals will survive the BTeV environment for at least a decade. Radiation damage to the crystals anneals at room temperature with a time constant of several hundred hours. Even with two crystal vendors, construction will be paced by crystal delivery time. The details of the mechanical structure behind the calorimeter need additional development.

BTeV's muon detector system is constructed from ~36,000 stainless steel proportional tubes mounted in three planes separated by two 1m thick magnetized iron toroids. The detector design (both mechanical and electronic) is traditional and quite well-advanced. A "vertical lazy susan" design to mount this detector in the constrained space in the BTeV toroid region has been developed. A conceptual design for a flexible trigger system that could be adapted to a wide range of luminosity and background conditions exists. If funding permitted, the muon subsystem could be ready to begin construction in a few months. Both the muon and straws use the same Penn ASDQ custom ASIC chip, a chip that must be ordered before the fabrication process disappears.

The trigger and data acquisition (DAQ) systems have as a goal to reject 99.95% of the background events and to record at least half of all B events to tape. The primary trigger involves identifying bottom hadrons by their long lifetimes using the pixel detectors, and a secondary trigger identifies them via decays involving muons. An unusual aspect is that full events are not written to data storage for offline analysis, but rather DST-like data. The trigger hardware revolves around two farms of processors: digital signal processors and field programmable gate arrays at Level 1, a custom Level 1 switch (still at an early state of design) and commodity CPUs at the higher levels. The possibility of use of commodity CPUs at Level 1 has been and will continue to be investigated. The DAQ has two custom parts: the clock distribution boards and data combiner boards (DCBs), both with a conceptual design, but not yet at the level of a technical design.

1.1 Vertex, Toroidal Magnet, Beam Pipes

Findings

Cost and Schedule:

- WBS 1.1 covers the Vertex Magnet (VM), Toroid Magnets (TM), and the Be vacuum beam pipes which contain the beam as it traverses the spectrometer. We found the technical goals to be clear and the technology used to meet this goal is well known. Tasks down to at least WBS level 5 were incorporated into the master project schedule. All tasks included cost estimates including M&S and SWF in FY05 dollars. Contingency at an average of 25% is also included. Reasonable milestones were also identified. 1.1.4 and 1.1.5 were assumed to use physicist labor and had no costs associated with them.

- A "drill down" was performed on the VM. We were able to go down to WBS level 5. The tasks were resource loaded and the cost and time estimates were credible and supported by BOEs. The VM assembly and testing tasks has a predecessor of parts procurement when it should have been the building outfitting. The successor should have been defined as the beginning of the 2006 shutdown, but was a typed in date.

Technical:

- The technical requirements for the VM were spelled out in the TDR. The TDR addresses how the Meast SM3 magnet will meet these requirements. The magnet was magnetostatically modeled with new pole piece inserts using ANSYS. These were not the final design pole pieces. Because the vertical bend of the VM is felt by the TeV beam, two compensating 10' B2 dipoles will be used to offset it creating a '3-bump'. This implies that the magnets must be ramped during each store. The TDR proposes two methodologies for accomplishing this. The level 2 manager expressed some concern that there may be some yet unknown eddy currents during ramping which could present a non-linearity to the TeV beam lattice. He claimed the magnet will be tested for this after assembly at C0 when it is ziptracked. During breakout, we learned there are no spare coils for the SM3 and none are planned. The existing coils were tested electrically and for clear cooling passages. There are no plans to refurbish them. The assembly and installation plans for the magnet were included in the TDR.

- The TDR also included the technical requirements for the TMs. There was a detailed description of the proposed design as well. The TMs will require new coils and for the most part will use steel recycled from the SM12 magnet. Some new steel will need to be purchased. The two 10′ compensating B2 magnets will be inserted inside a hole in the TMs. These existing magnets including a spare have been identified and tested. This magnet inside a magnet system was modeled for field distortions. The inserted B2 created nonuniformities in the TM field and vice versa. In the breakout, we were told that there was no physics issues with the nonuniformity of the toroid, but there was concern about the B2's affect on the TeV lattice. It was also mentioned that they recently increased the gap between the B2 and the TM from 1 cm to 2.5 cm in order to reduce the effect on the B2 and to make it easier to install and remove. This change has not yet been modeled. An assembly, installation, and testing plans were included in the TDR. We assume that the coils from non-spectrometer side of the IR could serve as spares? Studies are underway to fortify the muon filter support

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- The Be beampipe design will use two existing CDF pipes which will be modified by a vendor which specializes in Be. The design is well along but TDR mentions that more work is needed on the flange designs including prototyping.

Risks:

- A risk analysis was performed for this section and the only "risk events" identified were with the beampipe flanges and the beampipe assembly. They were assigned a high impact and a mitigation plan was included. The mitigation plan seem to imply fabricating spares, but it was unclear whether this was in the project plan.

Comments

- We felt that the cost, schedule, documentation, and design was at the CD-1 level with minor updates and cosmetic changes and very near CD-2 level. Assuming the scheduled resources, CD-2 could be accomplished by July.

- The recent decision to install toroids on the south (non-spectrometer) side is reasonable

- The project has calculated that the disassembly, reassembly, and ramping of the VM doesn't pose a "risk event", but we are somewhat nervous about this one of kind, essential part of the experiment which could have a very high impact. We note that there is precedent at Fermilab for not having spare spectrometer magnet coils.

- It is important that compensating B2s be measured for field nonuniformities after they are inserted in the toroids which could possibly impact the TeV lattice. The field strength could also be affected. There is also a small possibility of a problem with the VM while it is ramping.

- The VM schedule could be impacted by a slippage in the BO of the C0 hall.

- The beam tube has a 17% contingency. This may be a little light due to the design work which remains. It was difficult to determine from the documentation whether the project plans to build a spare. If a spare is intended, the contingency may be close, but previous experience has shown that Be beam tube fabrication is difficult and high risk, If no spare is included, the project may want to increase contingency for a replacement in case there are problems. The vendor quote specifically excludes liability for damage to the CDF beam tubes.

<u>Recommendations</u>

1 The schedule and documentation needs to be updated to reflect recent changes and all the documentation needs to be proofread before the Lehman review. The breakout presentation needs to include much more detail about the project.

2 The TDR should include a clearer discussion of the field nonuniformities in the B2s.

3 A discussion of the safety issues associated with the fragile Be beam tube should be included in the TDR. How is it protected? Any special handling? What happens if it ruptures? Will there be contamination issues?

4 The BOEs should be beefed up significantly to meet CD-2.

5 Complete the magnetic modeling of the VM with the final pole pieces and the TM's with the 2.5 cm gap between the B2s before CD-2. These tasks were not broken out in the cost and schedule.

1.2 Pixel Detector

Findings

- The technological baseline has been established.
- Study of the need for a RF shield inside the inner radius is underway.
- Significant progress has been made in the design of supports.
- The VM schedule could be impacted by a slippage in the BO of the C0 hall.

Comments

- The investigators have been very responsive to suggestions from previous reviews.
- The quality, completeness, and accuracy of written documentation continues to be outstanding.
- The contingency analysis has been performed with two different methods of estimation that yielded very consistent numerical results.
- Constraints imposed by funding profiles upon construction and by accelerator shutdowns upon assembly result in only 49 days of float in the installation schedule.

Recommendations

1 Finalize the RF shield study as early as possible to minimize risks to the subsequent design.

2 Add information on cost, schedule, risk, organization chart, and milestones to the pixel talk(s) that will be presented at the April 2004 Lehman Review.

3 Revise the documentation to emphasize that the baseline has been defined and to indicate clearly which among competing technologies has been chosen. Where studies of the backup technology will continue, ensure that the motivation is explained clearly.

4 Continue the studies of the impact of cooling loss with increasingly realistic modules.

5 Expand the TDR to describe more thoroughly the details of the module design and the R&D that remains to be done to complete that design.

6 Continue to develop a robust module assembly procedure.

1.3 RICH Detector

Findings

- A detailed schedule exists for the RICH sub-detector. Major acquisitions ramp up in FY06 and continue through FY08. Manpower commitments peak in FY08, but final installation in FY09 shows considerable effort also expended in this fiscal year.

- Critical path items include: the mirror array mechanics (due to technical reasons), and the front end electronics (deemed to be low risk items, are delayed until late in the project in favor of advancing the funding for the PMT and mirror acquisitions).

- The cost estimate basis is well detailed. Minor cost items, some estimated in previous years, have been escalated to FY05 dollars. Major cost items (such as the MAPMTs, HPDs and mirrors) have been re-confirmed within the last three months.

- Some items have been costed in common across all of the sub-detectors. For the RICH, these include HV, LV, cabling and slow controls. The costs for these items appear in the RICH sub-detector, but overhead and q/a costs appear in the integration project element.

- Some outside funding is available for the RICH. Approximately 600K in FY04-5 from NSF funds and an MRI have been committed to further electronics development, liquid radiator work and mirror tooling.

- Approximately 10% spares are included in the RICH sub-detector for installation needs (for example, there are 3 spare mirrors for the 16 needed).

Comments

- The RICH section of the TDR seems especially complete. Since the last review, detailed Monte Carlo work has been performed to study the liquid radiator system. The question of 2-inch versus 3-inch PMTs was examined. The cost versus improved resolution obtained was seen to point to retaining the baseline 3-inch PMT. Some very illustrative event displays for the liquid radiator system have been included.

- Since the last review, MAPMTs have replaced HPDs as the photodetector choice for the gas radiator system, on the basis of cost. Both of these detectors are from foreign suppliers. Over the last couple of years, the HPD costs have risen by 22%, while the MAPMT costs have remained flat, due to currency fluctuations, a concern noted in past reviews. The final choice for this detector element will be made in FY06, so fluctuations could again play a role. Technically however, the MAPMTs are a much easier device to work with.

- There has been major progress in fleshing out a detailed installation schedule since the last review. Items are now detailed to show task descriptions, manpower estimates and allotted calendar times.

- Manpower is concentrated from university sources. This varies from 7 to 16 FTEs with total labor varying from 10 to 22 FTEs over the same years (so ~ 75%). This seems especially tight in FY06-08, with substantial end-loading. Another university group to take on a major piece of the sub-detector (perhaps the liquid radiator system?) could alleviate this.

Recommendations

1 Continue to scrub the milestones. Make sure that finish as well as start dates are available for major items. Add mirror installation milestones to the assembly hall tasks. A sub-set of "Level 1.5" milestones would be beneficial for over-all project co-ordination.

2 Continue to flesh out the basis of estimate, especially the section on the RICH vessel construction examined during the breakout session.

3 Clarify the WBS Dictionary and Basis of Estimate section of the Management Notebook.

1.4 EM Calorimeter

Findings

- BTeV is currently working with 4 crystal vendors. Based on budgetary quotes from fall 2003 and spring 2004 they anticipate that they will split the order between a Russian vendor ($3.60/cc) and a Chinese vendor ($2.75/cc).

- Russian crystal procurement is on the critical path. The float for deliveries from the anticipated Russian vendor is 35 days. The small float is the result of a delayed startup because sufficient funds are not available until FY07.

- Crystal procurement from the anticipated Chinese vendor is also on the critical path with a float of 38 days. Production would begin in 2006 with a 4-year delivery schedule due to limited production capacity.

- 2000 hours of test beam at IHEP has been devoted to evaluating the response of the crystals. The energy and position resolution have been measured and the effects of radiation damage on the energy resolution of the calorimeter have been studied extensively. The results seem to indicate that at the expected dose rate only the crystals nearest the beam pipe will be adversely affected.

- The lead tungstate crystals have a significant temperature coefficient and require thermal isolation from heat generating elements in the Photomultiplier tube bases and electronics. The PMT bases are being designed to minimize heat dissipation and there are plans for thermal insulation of the crystals.

- Candidate photomultiplier tubes from various vendors have been tested for performance and radiation resistance.

- Essentially all of the funds available in FY05 for the calorimeter are dedicated to the QIE procurement. The QIE is implemented in a 0.8 micron process that could become obsolete soon, necessitating a rapid procurement. All other calorimeter electronics, that are primarily off-the-shelf components, come much later in the project due to funding limitations.

- The mechanical structure that holds the crystals in place is reasonably well understood.

- The mechanical structure has a float of 39 days and is scheduled for delivery in the summer of 2008. Work on the mechanical structure cannot begin until FY06 due to a lack of funds. Additional labor to advance the design of the motion tracks would increase the float.

- WBS 1.4 has about 60 milestones including about 5 Level I milestones that are of primary importance.

<u>Comments</u>

- The Scope of technical design is relatively well understood.

- The lead tungstate crystals provide some cost risk. The cost of crystals from Russia could increase due to rising electricity costs and other economic factors. The latest quote of $3.60/cc from the potential Russian vendor, obtained last fall, may no longer be valid based on the recent experience of CMS with this vendor. This should be covered by the 40% contingency on the cost of the crystals.

- Crystal procurement is on the critical path and presents significant schedule risk. Deliveries from the anticipated Russian vendor have a float of just 35 days. Given the history of crystal procurements and the recent experience of CMS, this is clearly not adequate. The reason for the small float is because funding will not be available until FY07. Forward funding of approximately $1M in FY06 could increase this float to a more acceptable level.

- A second Russian crystal vendor with large production capacity exists (Apatity). They have produced crystals for ALICE and may produce crystals for the CMS endcap. If forward funding is not available to advance the crystal production schedule BTeV may wish to consider adding Apatity as a third vendor. The cost of crystals from Apatity is larger ($5/cc) than the anticipated cost from the first two vendors.

- The details regarding the mechanical structure behind the calorimeter that includes the cable and fiber plant and cooling for electronics requires better specification. Because the cross section of the crystals is so small and is largely consumed by the photomultiplier tube, significant effort will be required to arrive at a routing scheme for the cables and fibers that still allows for adequate air flow. A similar challenge was presented by the KTeV calorimeter and the solution consumed considerably more effort than originally anticipated.

- The thermal simulation that has led to the current design to minimize temperature gradients in the crystals assumes that the temperature in the C0 collision hall is stable to 1 deg C. This seems optimistic unless the heating/cooling system in the hall is specifically designed to meet this specification. A temperature stability of several deg C should probably be assumed.

- The ratio of labor to M&S for the calorimeter project is 21%. This may seem a bit low but is due to the large M&S cost of the crystals and the fact that much of the labor is provided by students, physicists and Russian visitors.

- Reasonable basis of estimates exist for the cost drivers as well as many other items. Some items are still missing a basis of estimate, however. Most of the bases of estimates are budgetary quotes from potential vendors, experience from recent R&D or experience from the CLEO CsI calorimeter.

<u>Recommendations</u>

1 The collaboration should make every effort to accelerate the procurement of crystals either through forward funding or by qualifying 3 vendors.

2 More effort, including models and prototypes, should be applied to understanding the mechanical issues behind the calorimeter to ensure that the cable and fiber plant does not impede adequate airflow.

3 The thermal calculations should be repeated with a larger temperature variance in the C0 collision hall.

1.5 Muon Detector

Participants include groups from Pavia, Illinois, Vanderbilt and Puerto Rico totaling nine faculty members. The BTeV muon detectors are composed of 1152 "planks" of 32 stainless steel drift tubes. These planks will be assembled into larger units called "octants". Four octants form a "wheel", two wheels make a "view" and three stations of 4 views each will be installed in the BTeV toroidal magnets. The front-end electronics for each plank uses the Penn ASDQ custom ASIC, latches, and a serial link to the DAQ. The chambers operate on a mixture of 85% Argon and 15% CO_2 with an expected maximum occupancy of 2.5%, based on GEANT simulation of pbar-p collisions and MARS simulations of the C0 interaction region. The detector can provide an independent J/ψ trigger that can serve as a backup to the more ambitious pixel trigger. Efficiencies of this trigger range from 80% at low luminosity to 60% at the highest luminosities.

Findings

- The team has done a very good job in preparing for this review and in moving towards CD-1 and CD-2/3a.

- Prototype planks representing approximately 2% of the full system have been constructed and operated.

- Considerable effort has been expended in minimizing the detector installation time. For example, every detector octant is fully instrumented and tested before delivery to C0. Great care has been taken to minimize the number of service connections and to position them away from known interferences such as the floor and the toroid coils.

- A Technical Design Report describing the construction of the muon detector subsystem has been written, and a corresponding resource loaded schedule and WBS using Welcom's OpenPlan software has been developed. The WBS dictionary is approximately 25% complete. The schedule is paced by funding.

- Most cost estimates were bottom-up estimates based on vendor quotes (and for some large items, multiple vendor quotes). The Basis of Estimate appears complete, and the ability to find a specific item in it is much improved.

- Costs have remained stable since the last review (present estimate is within 2% of the October committee estimate). Price increases have occurred in the stainless steel tubes and the high voltage power supplies.

- Subproject management has shown an increase in facility with project management tools such as Open Plan.

Comments

- The detector design is well advanced, straightforward, technically adequate, robust and sound, and the project appears well managed
- In most cases, the materials and labor costs are plausible and the overall subproject contingency seems adequate. However, the contingency values for indivisual items seem to be too concentrated near the average. For example, items with relatively low risks (e.g. delrin plugs manufactured at Vanderbilt) were assigned contingencies close to items with high cost risks (e.g. stainless steel tubes) or items that have shown dramatic price increases over the course of preparing for CD-1 (e.g. CAEN high voltage supplies). The subproject would benefit from a contingency review with BTeV management.
- It was difficult for this reviewer to put numbers such as the 60% minimum trigger efficiency in context with the detector and physics requirements. BTeV may wish to consider a short section in their TDR discussing detector combined performance for elements that cross subsystem boundaries.
- The detector mounting scheme appears plausible, well documented, and the cost for this element is well understood. The addition of a steel plate to improve the quality of the toroid surface is a major improvement. The 0.040″ clearance for the detector installation seems unrealistically tight.
- The muon subsystem is ready for a DoE review for Critical Decision 1.
- The muon subsystem is nearly ready for a DoE review for Critical Decisions 2 and 3a. The project plan is complete and credible, but not yet well documented and reviewable. Readiness will require completion of the WBS dictionary. It would be useful to perform a reassessment of the contingency estimate and the milestones at this time. This probably can be achieved in a few months.

Recommendations

1 Complete the WBS Dictionary.

2 In conjunction with BTeV management, review the contingency estimates.

3 Add information on cost, schedule, risk, organization chart and milestones to the general muon talk that will be presented at the April Lehman review.

4 Increase the toroid gap between the steel and the chambers to at least one inch. This will require coordination with other impacted subprojects.

5 Consider the Penn ASDQ custom ASIC as a candidate for forward funding. The order for these chips must be placed before the fabrication process is no longer commercially available.

1.6 Straw Detector

Findings

- Since the October '03 Temple Review, there has been significant additions to the group: a full-time mechanical engineer and another mechanical engineer for 6 months, and a level 3 manager to oversee the production of straws chambers.

- A 96-channel prototype has been recently exposed to test-beam at MTest.

- A milestone for the group is the prototype of full-scale half-view including FE electronics.

- The group has studied the reduction in the hit occupancy in the beam region, if the tracking there were taken up by a larger silicon strip system. They've concluded that there is no significant gain in efficiency for pixel-seeded tracks, which form the bulk of tracks. However, a reduced occupancy would help the pattern recognition of non-pixel-seeded tracks, due to the reduction of ghost combinations. Overall, the group does not see large benefit in increasing the size of the silicon strip system.

- Cost and time estimates relied heavily on experience with building the 96-channel prototype.

- The project would incur significant delays if the process to produce the Amplifier/Shaper/Discriminator chips became commercially unavailable.

Comments

- Group has responded productively to recommendations from the October '03 Temple Review.

- Most of the design is at the TDR level, adequate for a CD-2 review. A few items are still at the advanced conceptual design level, e.g. the modules 1 and 0, where the design of the latter must accommodate the beam pipe and mechanical support of the silicon strips. This should be advanced to the TDR level fairly soon, due to the concentrated effort into this area by the Frascati/INFN group.

- The ASIC TDC development is behind that of the other straw system components. Currently, this object is known at the level of functionality and specifications.

- The group has demonstrated a deep understanding of the production of the physical chambers and the majority of the FE electronics. The WBS structure, schedule, risk analysis, and mitigation strategies are all well-developed and documented.
- The tracking efficiency study of non-pixel-seeded straws is still under development. The current pattern recognition has not utilized all handles to reduce ghost tracks. These handles are expected to greatly reduce this problem.
- In spite of the pattern-recognition early development, this reviewer is in agreement that increasing the silicon strip coverage is not worth the physics-gain.

<u>Recommendations</u>

1 Expedite the acquisition of ASDQ.

2 Work with the lab to advance the ASIC TDC development.

3 Work to complete the milestone of prototyping a full-scale ½ view including FE electronics. Current 96-channel prototype was built at Fermilab. In addition to crystalizing the module-0/1 technical design, building the full-scale prototype is a training exercise for all collaborators involved in the production.

4 Continue development of pattern recognition of non-pixel seeded tracking. This will help to tie RICH and ECAL analysis code development.

5 Continue participation by all collaborators in the testbeam of the 96-channel prototype.

1.7 Strip Detector

Findings

Cost and Schedule:

- The scope of the subproject is well defined and understood. Goals and the technology needed to implement the goals are specified.

- The WBS dictionary is adequate. Cost backup documentation also appears to be adequate. Many of the costs are taken directly from CDF and D0 experience.

- Standard critical path analysis with individual item floats was not provided. The schedule, as currently implemented in open plan, could not provide a realistic critical path analysis. Many items are funding limited and share common constraints. A written analysis of the critical path and associated mitigation plans was provided.

- Production rate for this detector is funding limited.

Technical:

- Progress has been made in conceptual design of the support structures. The design of the structure has been refined and simplified. The use of front/back assembly will make fabrication simpler.

- The design of the sensors has been simplified. The corner cut has been removed to decrease the technical risk.

Comments

Cost and Schedule:

- Estimation of contingency has improved since the last review. We do not recommend changes in the overall cost and contingency.

- The subproject has adopted a uniform prototype/preproduction/production model for procurements and assemblies. This should insure that the schedule is maintained and provides for some hidden contingency if prototype parts, such as the readout chip, are successful.

- Engineers and designers assigned to production are included in the subproject management task. They should be moved to the appropriate production tasks.

- The subproject now has L3 managers assigned. Some of these assignments appear to be placeholders with the managers not yet fully involved in the project. Refinement of these assignments will be needed before an efficient team is formed.

- INFN funding for this subproject is dependent on CD-3 approval and may not be available until some time after that approval is granted. This may be a substantial schedule risk and we suggest that the group explicitly address this possibility in their schedule.

Technical:

- The group has made good progress in the chip. A successful 0.25 micron prototype chip has been produced. Decisions will soon be made on the remaining technical details. The upcoming full prototype chip has a good chance of being fully functional.

- The group plans to use much of the technology developed for the D0 and CDF upgrades for hybrids and flex cables. They have made good progress in these areas and the preliminary designs appear solid.

- The chip is the only one risk factor called out. We agree that this is the major single technical risk item. A system level technical risk is coherent noise, which can completely ruin the performance of the strip system. The group is aware of this risk, but there is a danger of losing focus. An experienced and knowledgeable person should be assigned to oversee this area for BTeV.

- The plan for system integration and testing seems adequate. This should include grounding and shielding studies mentioned above.

- Some of the alignment tolerances quoted in the TDR are very tight (5 microns within the plane). The proponents may wish to consider whether such tight tolerances are necessary and achievable.

- The preliminary support structure design concept looks promising. However detailed calculations of coolant flow, thermal modeling, and support deflection were not yet available. We were not able to judge the overall viability of the integrated straw/silicon support structure design without more detailed information.

- The group should implement a production database (preferably in collaboration with other BTeV groups) to track parts procurement, testing, and assembly.

Recommendations

1 Conclude full engineering design of the silicon support and ladder. L3 managers and SiDet/FNAL personnel should be fully involved in the appropriate specifications and should verify that the required assembly techniques and tolerances are consistent with their capabilities. FEA and prototype modeling should be continued. The overall design should be reviewed by BTeV as soon as design calculations and prototype tests are available.

2 Scrub the open plan schedule for consistency in form and content with other subprojects. The schedule should provide a critical path analysis with individual task floats.

1.8 Trigger Electronics and Software

Findings

- The BTeV trigger design is innovative in two principal ways. The proposal is to have a displaced vertex trigger exploiting the properties of the silicon pixel detector at level 1, which imposes a very long level 1 decision time by current standards (hundreds of milliseconds). The second unusual aspect is not to write full raw data to storage for offline analysis, but rather DST-like data.

- BTeV spent significant effort in prototyping elements of the level 1 pixel trigger using existing technologies. The segment finder algorithm has been implemented on prototype hardware and its performance is being verified with simulated (Geant) data. Early results show good consistency with existing software simulations. A prototype of the track and vertex board also exists, and timing studies have been performed on DSP's installed on this board as well as on other embedded processors (pentium and PPC). Both prototypes also provide an important guideline in estimating the cost of the corresponding production boards, which represent significant fractions of the total trigger budget. For the level 1 switch, however, there is no prototype. A tentative, FPGA-based design is now described in the TDR.

- The level 1 muon trigger, as well as the global level 1 processors, will be based on the same hardware as the level 1 pixel trigger farmlets and are thererefore chronologically linked to these in the schedule.

- The level 2 and 3 triggers will run on a farm of commodity PC's and the hardware is thus well understood. The corresponding software effort is severely understaffed however, with only 35 to 50% of the required manpower identified. Based on the recommendations made during the last director's review, BTeV has formed a working group to develop a staged plan for the implementation of the data volume reduction.

- Following earlier recommendations, BTeV has invested in the development of monitoring and error handling tools for large-scale real-time systems. This effort is progressing on schedule, and should be sustained. It should be noted that as part of this, a very promising approach to the inter-process communications, which are critical to the integration of the system, has been identified and is under further exploration.

- Globally, the schedule appears to be well structured. One exception is the level 3 software development milestones. Except for a small number of items, the cost estimates are based on prototypes or existing commodity hardware, which have been (de)escalated based on historical data and can be considered reliable.

Comments

- The level 1 switch design is still at an early stage and it is not established that this can handle the particular requirements of the BTeV level 1 pixel trigger.

- We agree that the OSE message-passing operating system is a good candidate for use in BTeV. Its further exploration is to be encouraged.

- The creation of a working group for the staged implementation of data volume reduction is a positive evolution. Since raw data suppression can only be done with confidence in the reconstruction software performance, milestones in this part of the project will need to be based on demonstrated software performance on real data.

- An operation plan for initial data taking without data volume reduction has been developed, and additional data storage is now included in the cost estimate.

- We believe the current draft of the TDR is close to being sufficient for CD-2.

Recommendations

1 Develop the design of the level 1 switch further, perform an analysis of its behavior under simulated conditions, and implement a smaller test version as early as possible.

2 Continue the exploration of DSP alternatives for the level 1 farmlets, taking into account all factors, including I/O capabilities, compatibility with the inter-process communications framework, etc.

3 Continue evaluation of the commercial message-passing operating system developed by OSE.

4 Develop a well-structured, comprehensive set of milestones for level 3 software development.

5 Develop a set of objective criteria to determine when a subdetector's raw data can be suppressed.

6 Identify manpower to contribute to the level 3 software development.

1.9 Event Readout and Controls

Findings

- The data acquisition part of the experiment provides the Data Combiner Boards (DCB) that combine data from various front-ends before sending them on to level 1 buffers and, if applicable, the level 1 trigger. The level 1 buffers in their turn store the data until a trigger decision has been made, which can be after hundreds of milliseconds. Once the trigger decision is received, the data is either sent to a level 2/3 node, or the corresponding memory is returned for use by another event. The other custom hardware component part of WBS 1.9 is the clock distribution system.

- The data acquisition group is also responsible for slow control, databases, run management, event building, and temporary data logging before transfer to FCC.

- The schedule appears generally reasonable, with appropriate sets of milestones. The cost estimates are based on existing hardware components and are generally sound.

Comments

- The DCB design is not completed yet. In particular, the inputs to the DCBs specific to each subdetector are not specified. There is some progress however, in the sense that funding coming from the pixel subproject has been identified to develop a pixel detector DCB pre-pilot.

- The clock design has evolved, mainly based on the proponents' contributions to the accelerator work. Measurements of the jitter have been performed and the need for PLLs to regenerate and clean the clock has been identified. This knowledge needs to be translated into a complete design.

- The software needs are well specified and understood, and therefore present little risk. The funding profile pushes this development towards the end of the project, and consequently a version of run control with full functionality (partitioning, use of databases) will only be available in early 2009. Most of this delay is due to database development not scheduled to start until 2006.

- The current draft TDR is only a minor evolution from the existing CDR, and does not contain sufficient detail for all aspects of this part of the project for a CD-2 review.

Recommendations

1 Fully specify the inputs to the DCBs for each subsystem, and build a prototype for at least one of these.

2 Design the clock distribution scheme and build prototypes for each of the custom elements (including the receivers on the front-end boards).

3 In the schedule, decouple the run control partitioning functionality from its use of databases.

4 Review the TDR draft and increase the level of detail where needed.

1.10 Installation and Integration

Findings

- A tremendous amount of work has gone into further understanding of this subproject since the last review in October 2003.

- This WBS subproject presented its total cost at 6.8 M$ base cost with an estimated contingency of 50% for a total estimate of 10.3M$. Of this, 78% is labor and 22% M+S. This project has its labor contingency at 63% and its M&S contingency at 21%. The total project cost has increased 50% since the last "Temple" review in October 03.

- The installation estimates for each detector component's (L2 task) installation was originally developed by the other L2 managers and transferred to this WBS. As a result, the level of detail was not consistent across detector subprojects. These sections are now being reworked. Each subproject was asked for and has delivered an "installation narrative". An installation schedule is being developed for each detector based on these narratives. While all the narratives are now in hand, the schedule still needs work to include all of this information.

- A number of task forces have been assigned to look at issues such as the cable plant, relay racks and grounding issues, slow controls, survey and alignment issues to name a few. The results from these efforts have not made it into the project plan as of yet.

- Contingency on these tasks was done jointly with the other L2 managers

- This sub-project does not have substantial labor assigned to it. In its peak years (08 and 09) it only has allocated 5 FTE of technicians from PPD and never has more than 0.5 FTE of PPD design and drafting help.

- The WBS includes receipt of subassemblies from the other L2 tasks and provides for final installation of each detector into the C0 collision hall. With the exception of the magnets, each detector is assembled elsewhere and tested prior to being shipped to the C0 hall. Shipment costs are included in this WBS

- The project documentation is quite far along. The WBS for this task contains in excess of 600 separate activities. There is a first pass WBS dictionary as well as a preliminary cost analysis is complete.

- A random drill down on the WBS item showed that the cost and schedule is reasonably complete but that there is still work to be done. We were 50% successful. The basis of estimate book is incomplete.

- Milestones do exist for this project. There are currently 19 level 1, and level 2 milestones. Most of them occur quite late in the project.

- Many common items (such as relay racks, power supplies etc) have been removed from the individual projects and now reside in this project.

- The interaction between the activities in this project with the construction of the IR and civil construction of C0 is not well thought through. Who sets the priorities?

Comments

- The boundary between I&I and each of the other detector groups is much better defined than it was in the previous review. However, casual conversations with some of the other subproject leaders indicate that the role 1.10 play in the project is still misunderstood.

- FNAL resource requirements appear to be light for the size of the project. Reexamine the FNAL resources needed for this project (mechanical engineers, technicians, designers).

- The leadership of this subproject is a full time job. Trying to do this job along with being Mechanical Project Engineer is too much work

- Consider appointing a floor manager to handle space and schedule conflicts at C0.

- We had a difficult time identifying the labor resources required for installation of the gas mixing and distribution systems in the schedule. It was not clear where the main “cable plant” cables are purchased and built. Continue to look hard for missing items and false assumptions in the schedule

- Update the documentation found in the management notebook. The organization documents, installation integration and test plans, and risk analysis all needs to be updated and improved.

- Breakout talks need to be reworked and improved. This is an opportunity to present milestones, schedule details, labor and contingency for this subproject.

- The Installation and Integration project is dependent upon a substantial amount of labor from the other subprojects in order to complete its tasks. This makes it difficult for the reviewers to know whether adequate labor will be provided. There is also a risk that this labor will show up late due to schedule slippage in the detector fabrication

- The reviewer feels that the labor cost with contingency is too low given the current level of completeness in the schedule. The reviewer would add another 2M$ in labor contingency to bring the overall labor cost to 10M$ with a total contingency of 100%.

- The reviewer would raise the M+S contingency from 21% to 50% bringing the overall M+S to 3M$. The installation and infrastructure task always lags the rest of the project and will be the catch-all for various odd jobs. Furthermore, not all tasks have good specifications at this point.

Recommendations

1 The mechanical project engineer and the leader of subproject 1.10 should not be the identical person. This is too much work for one FTE.

2 Complete the transfer of each subprojects installation narrative information into the schedule.

3 Develop an installation coordination plan prior to CD-2
   a Develop a "sign-off" process between 1.10 and the sub projects to make sure that the common integration items match the detector subgroup specifications
   b Identify the manpower and plan to handle the numerous ES&H issues
   c Reexamine the FNAL manpower required in order to complete 1.10.

4 Incorporate infrastructure items into the list of milestones such as the completion of the gas mixing systems, electronics cooling water etc.

5 Scrub the WBS plan – look for missing tasks and inconsistencies.

6 Complete the cost estimates and BOE required in order to achieve CD-2

2.1 Interaction Region

Findings

General:

- The presentations given on the IR in this review, particularly those in the breakout session, were prepared more to provide updates to the committee on developments since the February IR review than as "dry run" presentations for the upcoming CD-1 DOE review.

Technical:

- Many AP findings from Feb04 Review have been addressed:
    - Beam loss and flux calculations finished; awaiting feedback from experiment
    - Straight Section vacuum requirements have been set
    - Assistant C0 IR Manager in Charge of Accelerator Physics has been named.

- Very few (~1) accelerator physicists are involved in project accelerator design.

- Nonetheless, a robust IR lattice design has been achieved:
    - IR insertion (B38 to C17) is transparent to rest of accelerator; thus, while tuning optics, rest of machine is undisturbed (unlike B0, D0 IR's)
    - Steering correctors, skew quad, BPMs are located in center of each triplet:
        - much better control of IP position and angle than in B0/D0
        - coupling due to rolled quads controlled via skew corrector
    - Low beta quads are on stands in the tunnel; not suspended in detector hall as in B0; better stability
- BPM in triplet is located inside spool, not attached to the Q2 quad

- Further tracking studies are lacking; past results still not understood

- Correctors are being redistributed or removed throughout region

- Corrector field quality requirements are still being discussed

- Effects of experiment dipole and spectrometer magnets on accelerator performance have not been examined

- Substantial progress has been made towards resolving some magnet system design questions, for example:
  - The yoke diameter has been increased so that the same end restraint system used for the LHC quads can be applied here.
  - Preliminary tests suggest that HTS leads of the existing Tevatron design can be used at I $\geq$ 9500A.
  - The magnet cryostat design has evolved towards a lower heat leak support structure.
  - Initial discussions have occurred with other labs that might build the correctors.

  However, as the designs have evolved, the CDR has not kept up with the presentations in all cases.

- The technical scope of the IR Level 2 project is well defined for this stage of the project planning:
  - The optics design is quite mature and was fully endorsed by the February IR Review.
  - The choice of technical components, especially for the new superconducting magnets, has been made and is appropriate.
  - The scope of other accelerator components is established.
  - The work to be done to reconfigure the accelerator during various upcoming shutdowns, culminating in installation of the new IR in 2009, is well defined.

Cost and Schedule:

- A WBS exists in Open Plan, and the cost and schedule estimates have been loaded into it. However, it still contains a considerable number of errors, as discovered as the committee did a number of "drill downs" to the lowest level. It has not yet been fully internally reviewed or proofread by the project personnel.

- The project personnel maintain that basis of estimate information exists for most or all of the cost estimate entries. This information has been entered into Open Plan for only a few tasks. Backup information exists in paper form in notebooks for some tasks, but not for most yet.

- The WBS dictionary entries in Open Plan are mostly absent. However, it is clear from discussion in the breakout session that the project personnel understand the definitions of the WBS elements, it is a matter of entering this information.

- A resource loaded schedule exists in Open Plan for the whole IR subproject. However, it has not been proofread (see above), nor has it been reviewed with AD or TD management with respect to the availability of the resources on the time scale called for by the schedule. In at least one case, an FTE profile output from Open Plan was said to be wrong by one of the level 3 managers.

- The accounting for special process spares – both the cost to BTeV in making the C0 straight section in FY2005 and the "profit" to BTeV when existing Tevatron components are removed in FY2009 – has not been included in the cost estimate. The IR Project Manager estimates that the net should be about $800k in BTeV's favor.

- The overall schedule for the IR subproject appears to be reasonable and achievable. However, due to the difficulties cited above, it was not feasible to review it in detail at this point.

- The critical path analysis tools in Open Plan are not understood well enough by the IR Level 2 and Level 3 managers to use them to extract the critical path. However, from their understanding of the work itself, they were able to identify the critical path as going through the correction magnet procurement and then the spool fabrication.

- No milestones have been established yet for the IR subproject.

- The cost profile shows $5.2M of M&S in FY05, of which ≥$4M is for long-lead items for the magnet system. The project team has not looked seriously at how to "soften" this up-front cost, but believes it may be possible to shift a substantial portion into early FY06, either by delaying the procurement or by phased procurement, without adversely affecting the schedule.

Comments

General:

- The IR sub-project team is made up of highly capable people, and planning is proceeding well.

- The presentations for the DOE review need to focus more tightly on the issues related to CD-1, and need to be "tuned" for clearer presentation than those given to this committee.

Technical:

- Project of this magnitude and this level of perturbation to the accelerator requires more accelerator physicists involved at this stage.

- Q2 quads are the strongest in ring (f = 4.4m), and are at the highest beta location (beta_max = 1600 m). It may be better to attach the BPM directly to quad, not in the adjacent spool.

- Tracking and beam-beam studies need more manpower. Completing and understanding the dynamic aperture calculations prior to the CD-1 review is an important final verification that the IR design is correct.

- Modifications to Tevatron standard correction circuits should be looked at carefully. Perturbations generated by standard tune control, chromaticity control, etc. when using a "new" corrector circuit distribution should be analyzed for resonance driving terms, beta waves, chromatic effects, etc.

- Specifications for corrector field quality need to be settled.

- The effects of B2 and spectrometer magnets on accelerator performance still need to be examined.

- It is important to verify, as soon as possible, the preliminary result suggesting that the existing Tevatron HTS power leads can be used for BTeV.

- Considerable detail was presented on the ramp rate dependence of the quench field in the LHC-type quadrupoles, but the conclusion is that there will be no R&D on this topic, and the accelerator ramp rate program will be adjusted to match the actual performance of the magnets built for BTeV. This is the appropriate conclusion.

- Only rough planning has been done so far for the installation in 2009. The overall picture plan appears to be reasonably well understood, but many details still need to be filled in before the CD-2 review.

Cost and Schedule:

- While much of the preliminary baseline cost, schedule and basis of estimate information has not been well documented yet, it is the judgment of this committee that the project team well understands the scope, and that it is “only” a matter of having sufficient time to document it. However, it should be emphasized that this documentation is very important, both for achieving CD-1 and eventually CD-2, and for planning, tracking and controlling the project as it is executed.

- The project technical, cost and schedule estimates and documentation are certainly not at the CD-2 (project baseline) level yet. However, depending on the standards applied for CD-1 (preliminary baseline range), they are probably sufficient for CD-1. In particular
  - The technical scope is, in fact, quite well defined overall.
  - The cost estimate is reasonable, based on considerable experience with similar work, and the final cost estimate is unlikely to deviate from what was presented here by more than – as a gross upper bound – ±25%.
  - The overall schedule is similarly understood based on past experience and appears to be achievable.

- The IR Project Manager states that his top priorities for the coming month, in preparation for the DOE review, are to proofread the cost and schedule estimates loaded into Open Plan and correct the mistakes, to assemble the BOE documentation, and to do a bottoms-up contingency analysis. These are the correct priorities, and all need be done for the DOE review.

<u>Recommendations</u>

1 Ensure that all of the plenary and breakout session talks clearly state the scope of work, and clearly and succinctly address the issues for CD-1. Hold serious "dry runs" for all of the talks prior to the review.

2 Assign accelerator physicists (~2-3) to participate in the finalization of the design in preparation for full CD-1 Review.

3 Edit and update the CDR to ensure that the technical designs described therein are consistent with those shown in the review presentations.

4 Proofread the data entered into Open Plan, and correct the known errors those found during the proofreading. Include TD and AD management to ensure that the resources required can be made available.

5 Remove all spares costs from the TEC.

6 Fill in entries for the WBS dictionary.

7 Assemble and document the basis of estimate for all tasks.

8 Do a bottoms-up contingency analysis.

9 Examine the strategies for placing procurements for long-lead items to minimize the FY05 cost.

3.1 Building Outfitting

Findings

- The C0 Outfitting subproject has been integrated into the BTeV project as WBS 3.0.

- The work breakdown structure and schedule have been developed to level 5 and included in the project master schedule. The Level 2 manager is also the Construction Manager.

- The overall anticipated cost of WBS 3.0 is $7,177 K, which includes contingency of 20%. This is an increase of $543K reflecting increased design detail and understanding of scope.

- WBS 3.0 has been divided into 3 phases which are largely sequential. This allows early completion of a test area in the C0 Assembly Hall.

- A conceptual design exists which includes drawings, and is significantly detailed.

- Cooling water (LCW) systems for the collision hall are included in WBS 2.0.

Comments

- There is some uncertainty about technology choices for computer cooling systems to be installed in Phase 2. The current cost estimates appear adequate for expected options.

- A model for shutdowns has been incorporated into the construction schedule, although the assignment of jobs among phases and shutdowns is still being resolved in detail. This area of scheduling needs to be completed and documented in one place for reviewability.

- The LCW systems for the collision hall need to be closely coordinated between WBS 3.0, WBS 2.0, and WBS 1.10.

- The time frame for Title II design for Outfitting Phase I is compressed with only approximately 2 months calendar time allotted; this is related to the brief interval expected between CD-3 and the start of construction.

- BTeV has utilized the inclusion of WBS 3.0 into the overall project to insure integration of detector requirements into the construction. The tools that have been used for this are meetings, WBS 1.10 (Detector Integration), and Fermilab's construction review and comment process. While this is adequate for setting initial requirements for the construction contracts, a formal change control process which includes the Construction Manager would ensure continued good integration during the 3 years construction will be underway.

- The portion of the EDIA that will be for FESS personnel chargebacks is to be accounted as Labor instead of M&S so the correct overhead rate is applied.

Recommendations

1 Create an advanced conceptual design which will permit a rapid finish of Phase I Title II design once CD-3 is granted.

2 Consider including a safety incentive in the estimates for construction.

3 Contingency has been increased from 20% to 25% to address the risk of improvement in the economy, which could result in higher bids.

4.1 Project Management, Cost and Schedule

The charge to the review committee requested an assessment of the readiness of the BTeV project to achieve CD-1 (verification of mission need and initiate preliminary design) and quickly advance through CD-2 (establish performance baseline and initiate formal design) and CD-3 (complete design and start of construction) by the end of calendar year 2004. The findings, comments, and recommendations below reflect this charge.

Findings

General Findings:

- The BTev project has done an incredible amount of work since the last review to get to this level of presentation. The foundation is set for the project to build upon for success.

- The BTev project has sufficient level of detail, subject to getting the funding profile right, to pass a CD-1 review. However, the project intends to quickly move from CD-1 into CD-2 and CD-3 this year and the level of project and organizational maturity required to accomplish this is not evident in the project management, cost and schedule performance arena.

- The project presented a Total Project Cost (TPC) of $187.9M with an average contingency of 36%. The committee finds that the TPC is adequate. The project CD-0 documentation identifies a schedule range of 2009-2012 for project completion. The project currently uses early starts and projects completion in 2009.

- We find the project has done an excellent job of addressing recommendations from previous reviews.

Project Management Findings:

- Key project management positions are about to be established and filled. An organization chart is contained in the Draft PMP.

- The committee finds that the recently changed funding model does not support the project plan. Planning is underway to use a combination of supplemental funding and rescheduling to mitigate this situation.

- Milestones are identified throughout the open plan software, however the project has not developed a comprehensive milestone table. As a result the committee is unable to determine consistency with the CD-0 milestone commitments established in February 2004.

- Drafts of the documents necessary to support CD-1 were made available to the committee. These include Project Execution Plan, Project Management Plan, Acquisition Plan, and Preliminary Hazard Assessment.

- The project is on the way to an impressive web based documentation and communication system.

- The project recently achieved CD-0 and has received a NEPA Categorical Exclusion determination.

- A project support office has been established, its functions identified, and included in the budget. Some positions are still being filled.

- A BTeV PMG (Project Management Group) meets regularly and serves/will serve as a change control board. The project meets regularly with DOE representatives from the Fermi Area Office and Office of Science HEP.

- The project schedule and integration of resources are produced through Open Plan software technology. The project has integrated three technical sub-project elements and a fourth element for project management into a single resource loaded plan. We find that no elements of the project are integrated into the earned value management system (COBRA) which affects the desire to quickly move through CD-2 and CD-3.

Cost Findings:

- The committee finds that the project is satisfying significant labor requirements through commitments from collaborating Universities and other National and International institutions. This "in-kind" contribution will be reduced to agreements in Memorandum of Understandings (MOU's). The committee finds that the project did not present draft MOU's or other documentation that could be used to satisfy project performance expectations.

Schedule Findings:

- The project did not present an overall critical path or summary level view of the project schedule. Total project integration was not presented in a "review able" manner.

- The committee finds that the project has not developed a comprehensive milestone log, however detailed milestones are identified in the management books prepared for each WBS element. Without the comprehensive milestone log, the committee is unable to determine consistency with the CD-0 milestone commitments established in February 2004.

Comments

- The BTeV team has an aggressive plan for achieving CD-1 CD-2 and CD-3a. The team must immediately behave like a project. You are on your way there, but have not all arrived yet. This can not be overstated at the moment.

- Given the desire to accelerate quickly through CD-2 and CD-3 this year, the project must present a sufficiently developed leadership and communication model to ensure success. We find that the leadership model presented can be appropriate for an MIE collaboration, but the model is not clearly articulated, nor is it universally accepted for implementation. The project presented a project leadership model (and organization chart in the draft PMP) that reflects overlapping roles and responsibilities between the Office of the Director, the BTev Project Manager, the BTev spokesperson, and the various representatives of the project management team. Communication of this series of complex relationships is a key expectation for future project reviews. The current BTev project leadership and laboratory management must do what ever it takes to achieve a level of confidence and universal buy in with project participants.

- The draft project management plan does not clearly explain the roles of the project leadership model. A large fraction of section 3 addresses roles that have no direct project function. The project should review the plan to ensure the roles described reflect the roles that are expected to deliver functional elements of BTeV.

- These drafts should be transformed into preliminary versions of the documents before the CD-1 review as required.

- One purpose of CD-1 is to verify mission need. The context for the BTev project, i.e. why it is important and why do it now, must be a strong message. The message is there, but it is presented as an “after thought” rather than a key message component. Not all committee members are high energy physicists.

- The project has significant labor commitments based on memorandum of understanding (MOU's) with Universities and other national and international institutions. It is important that the project have at least draft MOU's in place to document these commitments prior to entering into a performance baseline at CD-2, and that the project ensure a consistent approach in describing these important contributions in the baseline.

- The project completion (CD-4) Technical Objectives are presented in the PMP (and PEP?). You must be sure that there is a straightforward and unambigous way to define completion of the goals. Phrases such as "all systems must…meet the requirements set forth in the " TDR could be problematic.

- Detailed cost and schedules reflecting a level of design completion from conceptual design to more complete technical design were made available to the committee.

- The CD-0 document identifies the overall completion date as 1st quarter 2011 with a target completion date of 4th quarter 2009. Funding profile constraints may make it desirable to utilize some of this schedule contingency in project planning activities.

- The project did not present a risk management approach at this review. There is evidence that this may be done; however, not explicit. The risk management approach should include all elements of the project as well as the standard issues of technical complexities.

- Labor estimates supporting WBS element 1.10 reside primarily in the sub detector elements. The project must verify that the availability of staff matches the resource commitments for matrixed project tasks to prevent "double booking" of key personnel.

Recommendations

1 Clarify roles and responsibilities of the project management immediately. A project organization chart should be made available to the next reviewers. All members of the project team must understand this organization.

2 Fill key project management positions including Project Manager as well as ESH coordinator and procurement positions by the next review.

3 Complete the schedule and plan adjustments necessitated by the recent funding profile change before the DOE CD-1 review.

4 Implement formal change control within the project beginning with the CD-1 review.

5 Present a high level description/picture of the project's critical path and be able to relate critical acquisition needs to the schedule.

6 Further standardize and practice plenary and parallel talk presentations. Conduct joint rehearsals of all presentations to the CD-1 review. Talks should follow a standard template when describing cost, schedule, organization, and scope.

7 Maintain and present at reviews a table of key project milestones.

8 Transform all "draft" documents in support of CD-1 into "Final" or "Preliminary" versions as appropriate.

BTeV CD-1 Review Cost Estimate Spreadsheet

WBS	Items	Project Estimate FY05$									
		Base w/Indirects			Contingency %			Contingency $			Total Base w/Indirects and Cont.
		M&S	Labor *(1)	Total	M&S	Labor *(1)	Total	M&S	Labor *(1)	Total	
1.0	**Detector**	**55,135,272**	**38,346,766**	**93,482,041**	**35%**	**39%**	**37%**	**19,560,793**	**14,787,937**	**34,348,730**	**127,830,782**
1.1	Vertex, Toroidal Magnet, Beam Pipe	1,306,322	475,978	1,782,300	25%	24%	25%	331,111	115,849	446,960	2,229,261
1.2	Pixel Detector	8,057,051	7,448,777	15,505,828	42%	37%	39%	3,394,903	2,729,894	6,124,797	21,630,627
1.3	RICH Detector	9,907,094	2,185,026	12,092,120	38%	27%	36%	3,754,746	598,302	4,353,048	16,445,169
1.4	EM Calorimeter	10,070,074	2,157,616	12,227,691	35%	27%	33%	3,494,688	577,620	4,072,308	16,300,000
1.5	Muon Detector	2,985,031	977,579	3,962,610	40%	28%	37%	1,194,877	272,231	1,467,108	5,429,719
1.6	Forward Straw Tracker	5,289,565	4,238,558	9,528,123	26%	33%	29%	1,382,970	1,387,701	2,770,671	12,298,795
1.7	Forward Silicon Microstrip Tracker	3,638,381	3,835,006	7,473,388	36%	32%	34%	1,299,486	1,237,379	2,536,865	10,010,253
1.8	Trigger Electronics and Software	6,904,653	5,130,889	12,035,543	33%	54%	42%	2,260,480	2,761,727	5,022,207	17,057,752
1.9	Event Readout and Controls	5,070,573	6,964,769	12,035,342	40%	29%	34%	2,040,010	2,021,675	4,061,685	16,097,028
1.10	System Installation, Integration, etc	1,906,528	4,932,568	6,839,096	21%	63%	51%	407,522	3,085,559	3,493,081	10,332,178
2.0	**Interaction Region**	**19,086,340**	**11,642,428**	**30,728,769**	**24%**	**66%**	**40%**	**4,656,971**	**7,634,536**	**12,291,507**	**43,020,276**
3.0	**C0 Building Outfitting**	**5,980,763**	**0**	**5,980,763**	**20%**	**0%**	**20%**	**1,196,152**	**0**	**1,196,152**	**7,176,915**
4.0	**Project Management**	**582,066**	**7,411,047**	**7,993,144**	**22%**	**24%**	**23%**	**128,133**	**1,748,134**	**1,876,267**	**9,869,382**
	Total	80,784,441	57,400,241	138,184,717	32%	42%	36%	25,542,049	24,170,607	49,712,656	187,897,355

Note: (1) - Labor includes FNAL and University Labor

WBS	Items	Committee Estimate FY05$											
		Base w/Indirects			Contingency %			Contingency $			Total Base w/Indirects and Cont.		
		M&S	Labor *(1)	Total	M&S	Labor *(1)	Total	M&S	Labor *(1)	Total			$ CHANGE
1.0	**Detector**	**55,135,272**	**38,346,766**	**93,482,038**	**36%**	**43%**	**39%**	**20,106,535**	**16,634,946**	**36,741,481**	**130,223,519**		2,392,737
1.1	Vertex, Toroidal Magnet, Beam Pipe	1,306,322	475,978	1,782,300	25%	24%	25%	331,111	115,849	446,960	2,229,260	NC	
1.2	Pixel Detector	8,057,051	7,448,777	15,505,828	42%	37%	39%	3,394,903	2,729,894	6,124,797	21,630,625	NC	
1.3	RICH Detector	9,907,094	2,185,026	12,092,120	38%	27%	36%	3,754,746	598,302	4,353,048	16,445,168	NC	
1.4	EM Calorimeter	10,070,074	2,157,616	12,227,690	35%	27%	33%	3,494,688	577,620	4,072,308	16,299,998	NC	
1.5	Muon Detector	2,985,031	977,579	3,962,610	40%	28%	37%	1,194,877	272,231	1,467,108	5,429,718	NC	
1.6	Forward Straw Tracker	5,289,565	4,238,558	9,528,123	26%	33%	29%	1,382,970	1,387,701	2,770,671	12,298,794	NC	
1.7	Forward Silicon Microstrip Tracker	3,638,381	3,835,006	7,473,387	36%	32%	34%	1,299,486	1,237,379	2,536,865	10,010,252	NC	
1.8	Trigger Electronics and Software	6,904,653	5,130,889	12,035,542	33%	54%	42%	2,260,480	2,761,727	5,022,207	17,057,749	NC	
1.9	Event Readout and Controls	5,070,573	6,964,769	12,035,342	40%	29%	34%	2,040,010	2,021,675	4,061,685	16,097,027	NC	
1.10	System Installation, Integration, etc	1,906,528	4,932,568	6,839,096	50%	100%	86%	953,264	4,932,568	5,885,832	12,724,928	Note (1)	2,392,750
2.0	**Interaction Region**			**23,399,769**			**40%**			**9,359,908**	**32,759,677**	Note (2)	-10,260,599
3.0	**C0 Building Outfitting**	**5,980,763**		**5,980,763**	**25%**	**0%**	**25%**	**1,495,191**		**1,495,191**	**7,475,954**	Note (3)	299,039
4.0	**Project Management**	**582,066**	**7,411,047**	**7,993,113**	**22%**	**24%**	**23%**	**128,133**	**1,748,134**	**1,876,267**	**9,869,380**	NC	
	Total	61,698,101	45,757,813	130,855,683	35%	40%	38%	21,729,859	18,383,080	49,472,846	180,328,529		-7,568,826

Yellow highlighted cells have been changed by the Review Team

Notes:

(1) WBS 1.10 -

M&S - I+I scheduling process is lagging the other sub projects. Its schedule is incomplete at the moment. The systems are not well enough defined to assign a relatively small 21%M+S contingency. For example, the slow control costs are based on CDF's slow control system. This technology choice has not yet been determined. There are others available -- not all of which are within 20% of each other in cost. Furthermore, hardware costs for cryo piping to the pixel system are not included at the moment. Based on this, I increased the contingency from 21% to 50%

Labor - Labor cost is low. Labor involved in cabling, gas system construction, rack installation all appear to be too small or absent at the moment. There is no floor manager on the project and there should be. There are still unknowns in the schedule since not all project narratives have been entered into the schedule. 0.5 FTE of design/drafting effort throughout the project seems insufficient. As a result, I increased the contingency from 63% to 100%.

(2) WBS 2.0 - Removed cost of Spares for Operations and corrected for the HTS lead miscounting.

(3) WBS 3.0 - Contingency has been increased from 20% to 25% to address the risk of improvement in the economy, which could result in higher bids.

Appendix A.

Charge for the Director's Review of BTeV Project March 30 – April 1, 2004

This charge is for the Committee to conduct a Director's Critical Decision – 1 (CD-1) Review of the proposed BTeV project at Fermilab. Approval of CD-1 will allow the expenditure of funds for design to proceed from the Conceptual Design phase to the more detailed design phase.

Approval of CD-1 by DOE officials is based on a ***Conceptual Design*** for the project, a ***cost and schedule baseline range***, and some additional project management documents. The technical part of the review will focus on the conceptual designs for the IR and the Building Outfitting and the Technical Design Report (a more advanced stage of design) for the Detector. It will answer the questions, **will these designs meet the requirements and specifications set forth in the Conceptual Design Report (CDR)** and **are the designs sound**. ***The cost and schedule ranges are usually based on a detailed WBS – Work Breakdown Structure, WBS Dictionary, BOE – Basis of Estimate documentation, risk and contingency analyses, RLS – Resource Loaded Schedule, and time phased funding and cost profiles. The committee is asked to review each of these items, for quality, completeness, and accuracy***. Furthermore, the committee is asked to ***review and assess the quality of and comment on the additional formal project management documentation required for CD-1 approval***. *Also, please evaluate BTeV responses to recommendations from the October 21-23, 2003 CD-1Director's Review and the February 18-19, 2004 Director's Review of the BTeV IR.*

A Lehman Review corresponding to a DOE CD-1 Review is scheduled for April 27-29, 2004. Therefore, a key purpose of this review is to ***assess the readiness of the BTeV Project for a Lehman CD-1 Review***. Constructive comments on presentation content, format, and style are requested.

The P5 (Particle Physics Project Prioritization Panel) evaluation and recommendation regarding BTeV as set forth in their report in 2003 which reads as follows: "The P5 supports the construction of BTeV as an important project in the world-wide quark flavor physics area. Subject to constraints within HEP budget, we strongly recommend an earlier BTeV construction profile and enhanced C0 optics." Additionally, DOE approved CD-0 "Approve Mission Need" for BTeV on February 17, 2004.

Fermilab and BTeV are planning for CD-3 approval and begin construction in the first quarter of FY2005. To achieve this goal BTeV will need a Lehman CD-2/3 Review in the summer of 2004. Therefore, the committee is asked to *comment as appropriate on BTeV's status regarding readiness to "establish a baseline budget*." Again, appropriate constructive comments on what remains to be done are requested.

Finally, the committee should present findings, comments, and conclusions at a closeout meeting with BTeV and Fermilab management and provide a written report soon after the review.

Appendix B

Director's CD-1 Review
of
BTeV March 30-April 1
REVIEW AGENDA

<u>Tuesday, March 30, 2004</u>	**1 West**
8:00 AM – 8:45 AM	Executive Session (Held in Comitium)
9:00 AM – 9:15 AM	Introduction
9:15 AM – 10:15 AM	Project Overview
10:15 AM –10:50 AM	Interaction Region
10:50 AM –11:05 AM	BREAK
11:05 AM – 11:30 AM	C0 Building Outfitting
11:30 AM – 12:30 PM	Tracking Systems (Pixel, Silicon & Straws)
12:30 PM – 1:30 PM	LUNCH on 2nd Floor Crossover
1:30 PM – 2:15 PM	Trigger & DAQ
2:15 PM – 3:15 PM	Particle Identification Systems (RICH, EM calorimeter & Muon)
3:15 PM – 3:30 PM	BREAK
3:30 PM – 4:15 PM	Mechanical and Integration
4:30 PM – 6:30 PM	Executive Session (Held in Comitium)
7:00 PM	Dinner at Chez Leon

<u>Wednesday, March 31, 2004</u>	
8:00 AM – 12:00 Noon	Technical/Cost/Schedule/Mgmnt Breakout Sessions
	(See Breakout Chart)
12:00 Noon – 1:00 PM	LUNCH
1:00 PM – 2:30 PM	Continue Breakout Sessions
2:30 PM – 3:00 PM	BREAK
3:00 PM – 4:30 PM	Executive Session (Held in Comitium)
4:30 PM – 6:00 PM	Begin Writing Report

<u>Thursday, April 1, 2004</u>	
8:00 AM – 11:00 AM	Continue Writing Report
11:00 AM – 1:00 PM	Dry Run of Closeout (Held in Comitium)
(11:45 AM – 12:30 PM)	Grab Working LUNCH (continue Dry Run of Closeout)
1:00 PM – 2:00 PM	Finish Writing Report
2:00 PM – 3:00 PM	Upload Report Sections
3:00 PM – 4:00 PM	Closeout w/ BTeV and Fermilab Management (1 West)

Breakout Sessions for Wednesday, March 31, 2004

Breakout Session 1, Interaction Region WBS 2.0		
Breakout Session 2, Building Outfitting WBS 3.0		
Breakout Session 3, Mechanical and Integration		
1.1	Vertex, Toroidal Magnet, Beam Pipes	
1.10	Installation, Integration, etc	
Breakout Session 4, Silicon Tracking Systems		
1.2	Pixel Detector	
1.7	Strip Detector	
Breakout Session 5		
1.3	RICH Detector	
Breakout Session 6		
1.4	EM Calorimeter	
Breakout Session 7		
1.5	Muon Detector	
1.6	Straw Detector	
Breakout Session 8, Trigger and DAQ		
1.8	Trigger Electronics and Software	
1.9	Event Readout and Controls	
Breakout Session 9, Cost and Schedule		
Breakout Session 10, Management		

Appendix C

Director's CD-1 Review
of
BTeV March 30-April 1
REVIEW PARTICIPANTS

Review Committee

Ed	Temple	Review Chair
Greg	Bock	Reviewer
Gustaaf	Brooijmans	Reviewer
		Columbia U.
Rick	Ford	Reviewer
Dean	Hoffer	Reviewer
Don	Holmgren	Reviewer
Ron	Lipton	Reviewer
Hogan	Nguyen	Reviewer
Rob	Plunkett	Reviewer
Ron	Ray	Reviewer
Rob	Roser	Reviewer
Sally	Seidel	Reviewer
		U. New Mexico
Jim	Strait	Reviewer
Linda	Stutte	Reviewer
Mike	Syphers	Reviewer
Dale	Knutson	Reviewer - ANL
Thomas	LeCompte	Reviewer – ANL

Observers

Dave	Carlson	Observer
Joe	Collins	Observer
John	Cooper	Observer
Roger	Dixon	Observer
Peter	Garbincius	Observer
Bob	Huite	Observer
Bob	Kephart	Observer
Mike	Lindgren	Observer
Claudio	Luci	Observer
Antonio	Paolozzi	Observer
Vicky	White	Observer

BTeV Participants

Marina	Artuso	BTeV
Ed	Barsotti	BTeV
Stefano	Bianco	BTeV
Mark	Bowden	BTeV
Chuck	Brown	BTeV
Joel	Butler	BTeV
Harry	Cheung	BTeV
Mike	Church	BTeV
Brad	Cox	BTeV
Robert	Downing	BTeV
Bill	Freeman	BTeV
Erik	Gottschalk	BTeV
Alan	Hahn	BTeV
Joseph	Howell	BTeV
Penelope	Kasper	BTeV
Jim	Kerby	BTeV
Yuichi	Kubota	BTeV
Simon	Kwan	BTeV
Tom	Lackowski	BTeV
Paul	Lebrun	BTeV
Patricia	McBride	BTeV
Dario	Menasce	BTeV
Luigi	Moroni	BTeV
Paul	Sheldon	BTeV
Tomasz	Skwarnicki	BTeV
Sheldon	Stone	BTeV
Alexandre	Vasiliev	BTeV
Margaret	Votava	BTeV

DOE

Ron	Lutha	DOE
Jane	Monhart	DOE
Paul	Philp	DOE

Appendix D.

Director's CD-1 Review
of
BTeV March 30-April 1
TABLE OF RECOMMENDATIONS

No.	Responsible	Recommendation	Status	Date
1.1 Vertex, Toroidal Magnet, Beam Pipes				
1.1.1		The schedule and documentation needs to be updated to reflect recent changes and all the documentation needs to be proofread before the Lehman review. The breakout presentation needs to include much more detail about the project.		
1.1.2		The TDR should include a clearer discussion of the field nonuniformities in the B2s.		
1.1.3		A discussion of the safety issues associated with the fragile Be beam tube should be included in the TDR. How is it protected? Any special handling? What happens if it ruptures? Will there be contamination issues?		
1.1.4		The BOEs should be beefed up significantly to meet CD-2		
1.1.5		Complete the magnetic modeling of the VM with the final pole pieces and the TM's with the 2.5 cm gap between the B2s before CD-2. These tasks were not broken out in the cost and schedule.		

No.	Responsible	Recommendation	Status	Date
		1.2 Pixel Detector		
1.2.1		Finalize the RF shield study as early as possible to minimize risks to the subsequent design.		
1.2.2		Add information on cost, schedule, risk, organization chart, and milestones to the pixel talk(s) that will be presented at the April 2004 Lehman Review.		
1.2.3		Revise the documentation to emphasize that the baseline has been defined and to indicate clearly which among competing technologies has been chosen. Where studies of the backup technology will continue, ensure that the motivation is explained clearly.		
1.2.4		Continue the studies of the impact of cooling loss with increasingly realistic modules.		
1.2.5		Expand the TDR to describe more thoroughly the details of the module design and the R&D that remains to be done to complete that design.		
1.2.6		Continue to develop a robust module assembly procedure.		
		1.3 RICH Detector		
1.3.1		Continue to scrub the milestones. Make sure that finish as well as start dates are available for major items. Add mirror installation milestones to the assembly hall tasks. A sub-set of "Level 1.5" milestones would be beneficial for over-all project co-ordination.		

No.	Responsible	Recommendation	Status	Date
1.3.2		Continue to flesh out the basis of estimate, especially the section on the RICH vessel construction examined during the breakout session.		
1.3.3		Clarify the WBS Dictionary and Basis of Estimate section of the Management Notebook.		
1.4 EM Calorimeter				
1.4.1		The collaboration should make every effort to accelerate the procurement of crystals either through forward funding or by qualifying 3 vendors.		
1.4.2		More effort, including models and prototypes, should be applied to understanding the mechanical issues behind the calorimeter to ensure that the cable and fiber plant does not impede adequate airflow.		
1.4.3		The thermal calculations should be repeated with a larger temperature variance in the C0 collision hall.		
1.5 Muon Detector				
1.5.1		Complete the WBS Dictionary.		
1.5.2		In conjunction with BTeV management, review the contingency estimates.		
1.5.3		Add information on cost, schedule, risk, organization chart and milestones to the general muon talk that will be presented at the April Lehman review.		
1.5.4		Increase the toroid gap between the steel and the chambers to at least one inch. This will require coordination with other impacted subprojects.		

No.	Responsible	Recommendation	Status	Date
1.5.5		Consider the Penn ASDQ custom ASIC as a candidate for forward funding. The order for these chips must be placed before the fabrication process is no longer commercially available.		
		1.6 Straw Detector		
1.6.1		Expedite the acquisition of ASDQ.		
1.6.2		Work with the lab to advance the ASIC TDC development.		
1.6.3		Work to complete the milestone of prototyping a full-scale ½ view including FE electronics. Current 96-channel prototype was built at Fermilab. In addition to crystalizing the module-0/1 technical design, building the full-scale prototype is a training exercise for all collaborators involved in the production.		
1.6.4		Continue development of pattern recognition of non-pixel seeded tracking. This will help to tie RICH and ECAL analysis code development.		
1.6.5		Continue participation by all collaborators in the testbeam of the 96-channel prototype		

No.	Responsible	Recommendation	Status	Date
		1.7 Strip Detector		
1.7.1		Conclude full engineering design of the silicon support and ladder. L3 managers and SiDet/FNAL personnel should be fully involved in the appropriate specifications and should verify that the required assembly techniques and tolerances are consistent with their capabilities. FEA and prototype modeling should be continued. The overall design should be reviewed by BTeV as soon as design calculations and prototype tests are available.		
1.7.2		Scrub the open plan schedule for consistency in form and content with other subprojects. The schedule should provide a critical path analysis with individual task floats.		
		1.8 Trigger Electronics and Software		
1.8.1		Develop the design of the level 1 switch further, perform an analysis of its behavior under simulated conditions, and implement a smaller test version as early as possible.		
1.8.2		Continue the exploration of DSP alternatives for the level 1 farmlets, taking into account all factors, including I/O capabilities, compatibility with the inter-process communications framework, etc.		
1.8.3		Continue evaluation of the commercial message-passing operating system developed by OSE.		
1.8.4		Develop a well-structured, comprehensive set of milestones for level 3 software development.		

No.	Responsible	Recommendation	Status	Date
1.8.5		Develop a set of objective criteria to determine when a subdetector's raw data can be suppressed.		
1.8.6		Identify manpower to contribute to the level 3 software development.		
		1.9 Event Readout and Controls		
1.9.1		Fully specify the inputs to the DCBs for each subsystem, and build a prototype for at least one of these.		
1.9.2		Design the clock distribution scheme and build prototypes for each of the custom elements (including the receivers on the front-end boards).		
1.9.3		In the schedule, decouple the run control partitioning functionality from its use of databases.		
1.9.4		Review the TDR draft and increase the level of detail where needed.		
		1.10 Installation and Integration		
1.10.1		The mechanical project engineer and the leader of subproject 1.10 should not be the identical person. This is too much work for one FTE.		
1.10.2		Complete the transfer of each subprojects installation narrative information into the schedule.		

No.	Responsible	Recommendation	Status	Date
1.10.3		Develop an installation coordination plan prior to CD-2 a Develop a "sign-off" process between 1.10 and the sub projects to make sure that the common integration items match the detector subgroup specifications b Identify the manpower and plan to handle the numerous ES&H issues c Reexamine the FNAL manpower required in order to complete 1.10.		
1.10.4		Incorporate infrastructure items into the list of milestones such as the completion of the gas mixing systems, electronics cooling water etc.		
1.10.5		Scrub the WBS plan – look for missing tasks and inconsistencies.		
1.10.6		Complete the cost estimates and BOE required in order to achieve CD-2		
2.1 Interaction Region				
2.1.1		Ensure that all of the plenary and breakout session talks clearly state the scope of work, and clearly and succinctly address the issues for CD-1. Hold serious "dry runs" for all of the talks prior to the review.		
2.1.2		Assign accelerator physicists (~2-3) to participate in the finalization of the design in preparation for full CD-1 Review.		
2.1.3		Edit and update the CDR to ensure that the technical designs described therein are consistent with those shown in the review presentations.		

No.	Responsible	Recommendation	Status	Date
2.1.4		Proofread the data entered into Open Plan, and correct the known errors those found during the proofreading. Include TD and AD management to ensure that the resources required can be made available.		
2.1.5		Remove all spares costs from the TEC.		
2.1.6		Fill in entries for the WBS dictionary.		
2.1.7		Assemble and document the basis of estimate for all tasks.		
2.1.8		Do a bottoms-up contingency analysis.		
2.1.9		Examine the strategies for placing procurements for long-lead items to minimize the FY05 cost.		
3.1 Building Outfitting				
3.1.1		Create an advanced conceptual design which will permit a rapid finish of Phase I Title II design once CD-3 is granted.		
3.1.2		Consider including a safety incentive in the estimates for construction.		
3.1.3		Contingency has been increased from 20% to 25% to address the risk of improvement in the economy, which could result in higher bids.		
4.1 Project Management, Cost and Schedule				
4.1.1		Clarify roles and responsibilities of the project management immediately. A project organization chart should be made available to the next reviewers. All members of the project team must understand this organization.		

No.	Responsible	Recommendation	Status	Date
4.1.2		Fill key project management positions including Project Manager as well as ESH coordinator and procurement positions by the next review.		
4.1.3		Complete the schedule and plan adjustments necessitated by the recent funding profile change before the DOE CD-1 review.		
4.1.4		Implement formal change control within the project beginning with the CD-1 review		
4.1.5		Present a high level description/picture of the project's critical path and be able to relate critical acquisition needs to the schedule.		
4.1.6		Further standardize and practice plenary and parallel talk presentations. Conduct joint rehearsals of all presentations to the CD-1 review. Talks should follow a standard template when describing cost, schedule, organization, and scope.		
4.1.7		Maintain and present at reviews a table of key project milestones.		
4.1.8		Transform all "draft" documents in support of CD-1 into "Final" or "Preliminary" versions as appropriate.		